State of California, Department of Transportation

Asphalt Concrete Plant Inspection Manual

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STATE OF CALIFORNIA
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Asphalt Concrete Plant Inspection Manual

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Virgin Aggregate - Natural occurring gravel, cobble or rock formations that have been screened or crushed into various sized aggregates. Aggregate sources can be classified into two different types, alluvium or hillside deposits.

Lime Slurry Treated Aggregates – A process that mixes aggregates with slurry comprised of one part dry hydrated lime and three parts water. The mixing of the aggregates and slurry is performed in a pugmill. Aggregates for each bin or stockpile are treated separately then allowed to set (marinate) for a minimum of 24 hours before being processed through the AC plant.

Supplemental Fine Aggregates - Includes baghouse fines, dry hydrated lime, portland cement, fly ash or limestone dust. Introduction of supplemental fine aggregates is discussed later in this manual, for each type of plant.

Aggregate Qualities - Desirable characteristics specified in the contract documents, such as well graded, crushed or natural, surface texture, durability, cleanness, density, absorption, abrasion resistant and affinity for asphalt.

AC Mix Designs - Aggregate, supplemental fines, asphalt binder and/or antistrip additives are received from the Contractor along with an X-Value or Target Value letter indicating the desired gradings and bin percentages for the proposed mix design. Depending on the type of project, Caltrans laboratories or Private laboratories may perform all the testing to prepare a mix design for the Contractor. Many different tests are performed before the mix design is approved and this may take up to a couple of weeks. At this writing, Caltrans only recognizes mix designs created using the Hveem method.

Certificate of Compliance – Each load of asphalt binder is to be accompanied by a "Certificate of Compliance". The certificate shall include the shipment number, type of material, specific gravity of material, refinery, consignee, destination, quantity, contract or purchase order number and date of shipment. The certificate shall include a statement that the material complies with the Contract Special Provisions and the Standard Specification and must be signed by the vendor or the vendor's representative. Any asphalt binder furnished without a Certificate of Compliance shall not be used in the work until the Engineer has had sufficient time to make appropriate tests and has approved the asphalt for use. Even with a Certificate of Compliance the asphalt binder must be sampled and tested on a daily basis.

Paving Asphalt - Asphalt is the residue that remains after crude oil is refined. Caltrans uses asphalts with an AR designation, such as an AR-4000. The AR (Aged Residue) grading system uses the Rolling Thin film Oven to condition the binder sample. This procedure uses heat and air on a moving film of semi-solid asphalt. The effects of this test are determined by measuring the properties of the asphalt binder before and after the treatment. The number designation after the AR, is the viscosity of the binder.

Liquid Anti-Strip – A liquid additive (adhesion promoter) made with proprietary ingredients and mixed with the asphalt binder. The proportioning system for batch and continuous mix plants differs greatly. Continuous mixing facilities utilize a mass flow, Coriolis effect meter to introduce the liquid anti-strip into the asphalt binder. Batch plants use a weigh pot to measure the amount of liquid anti-strip needed for each batch of asphalt concrete. Pre-heating liquid anti-strip to near 150° F prior to its use, reduces the viscosity of the anti-strip and make it easier to move through a pump.

PBA Grade Asphalt - The term “PBA” signifies “Performance Based Asphalt”.
There are at least seven different PBA grades of asphalt binder, ranging from PBA-1 to PBA-7. PBA binders were developed for specialized circumstances, such as extremely cold and extremely hot environments. Most often paving asphalt is modified with polymers to meet the minimum requirements for PBA binders. These asphalt types are currently being used in the majority of asphalt pavements produced for Caltrans.

Modified Asphalt - AR grades of paving asphalt are heated to 400˚F ± then blended with extender oil, high natural rubber and finely graded crumb rubber, then the rubberized asphalt binder is allowed to react in a mixing tank for a minimum of 45 minutes before being mixed with crushed aggregates. Caltrans is currently looking at other types of modified asphalt for use in the future.

Terminal Blended Rubberized Asphalt Binder – This process occurs at the refinery terminal and blends AR-Grade asphalt binders and 15 percent crumb rubber. The ingredients are combined at high temperature near 400°F and a high shear mixer blends the rubber and asphalt together. The asphalt binder and the crumb rubber are allowed to react then loaded into a tanker truck and shipped to the asphalt plant. The terminal blended rubberized asphalt binder is then stored in the contractor’s tanks at the AC plant.

Recommended Bitumen Ratio Range – This is applicable to asphalt concrete made for non-QC/QA projects. The Materials laboratory recommends an optimum bitumen content or range, lets say for instance is from 5.8 to 6.1 percent. The Engineer/plant inspector may order from 5.7 to 6.2 percent asphalt binder without having to adjust the asphalt binder bid price and/or requesting a new mix design. You will notice there is a difference between the two ranges indicated by ± 0.1 percent.

Asphalt Concrete Types - Type “A” and Type “B’ asphalt concrete are differentiated by a couple of characteristics, such as, aggregate crush counts and stabilities. The maximum nominal aggregate size for asphalt concrete is designated by dimension, such as 19 mm, 12.5 mm or 9.5 mm. “Dense Graded” is referring to a well-graded aggregate and “Gap Graded” is referring to an aggregate that has openings in the grading to allow for additional asphalt binder. “Maximum Medium” AC is a well-graded aggregate throughout the range of sieves, whereas “Maximum Coarse” AC is just that, a coarser grading, meaning fewer percent passing all sieves. “Open Graded” asphalt concrete has very few, if any, fine aggregates passing the 2.36 mm sieve.

Recycled Asphalt Pavement (RAP) - Old asphalt concrete pavements that have been removed from an existing roadway and stockpiled. During production the RAP is crushed, screened and proportioned with heated virgin aggregates, hot asphalt binder and then mixed in an asphalt plant. Batch plant and continuous mixing plants handle RAP in different manners and each application will be covered later in this manual.

Cold Storage - This refers to how the virgin aggregate is handled and fed to the asphalt plant (batch or continuous mix) prior to being heated in the drier drum. The following systems are the most commonly used: 1) Rectangular open bins fed by a loader from the top. 2) Stockpiles separated by large bulkheads, feeding aggregates onto a belt located in a tunnel under each stockpile. 3) Multiple storage silos, with adjustable gate openings deliver aggregates to a collection belt. Before being fed to the drier, Caltrans requires that aggregates be separated into 3 or more sizes and stored separately.

Cold Feed Low-Flow Interlocks - Each cold feed bin shall be equipped with a device that monitors the depth of aggregate between the troughing rollers. The device will automatically shut the plant down whenever the depth of aggregate drops 30 percent below the target depth. A small time delay, usually 10 seconds or less, is allowed and set into the plant controller at the time of CT 109. This device shall be in good working condition and functioning properly whenever the plant is operated.

Cold Feed No-Flow Interlocks – Each cold feed bin shall be equipped with a second device located either in the stream of aggregate beyond the belt or where it will monitor movement of the belt by detecting revolutions of the tail pulley. The device shall automatically and immediately shut the plant down when there is no flow. This device shall be in good working condition and functioning properly whenever the plant is operated.

Scalping Screen - A large rectangular vibrating screen, typically placed after the collection belt and before the weighbelt. The screen openings allow the largest size aggregate through and remove all oversized materials, including tree roots and clay balls. A scalping screen is usually placed in the cold feed system of continuous mix plants.

Rate of Flow Indicators – All asphalt meters and aggregate belt scales, at continuous mixing plants, shall be equipped with rate-of-flow indicators that show the delivery rates for aggregate and asphalt binder.

Weighbelt - A weighing system that is designed to continuously determine the weight of material flowing over the scale at any given time. Combined aggregates are fed from a collection belt, onto another conveyor belt (weighbelt) and over an in-line belt weigher, also known as a "weighbridge". The plant controller calculates the amount of aggregate being fed to the drier drum using the mass of material on the weighbridge and the belt speed. An indicator located in the control room displays the rate at which the material is flowing, usually in tons per hour.

Totalizers – Asphalt meters and aggregate belt scales shall be equipped with resettable totalizers. The totalizers are used to determine the total amount of asphalt and aggregate introduced into the asphalt concrete mixture. Some of the totalizers used to determine aggregate quantities include moisture, a quick calculation performed by the plant inspector results in dry aggregate totals. Some computerized plant controllers have asphalt and aggregate totalizers available within the computers operational software, ask the plant operator for assistance with this type of totalizer.

Drying - Aggregate is fed directly to a drier or a drier-drum mixer at a uniform rate, then heated by a burner system using various types of fuel. The aggregate feed rates may need to be decreased if the temperature of material leaving the drum is not adequately heated. Complete combustion of all burner fuel is required by Caltrans.

Moisture Correction - Continuous mixing AC plants must have aggregate moisture determined on a regular basis (every couple of hours) to correctly proportion asphalt to the aggregate. The moisture correction may apply to each cold feed bin, in this case, each bin must be sampled and percent moisture determined separately. The moisture correction may also apply to the combined aggregates, in this case, a combined aggregate sample is taken and the percent moisture is determined on the mixed sample.

Hot Elevator (Hot Stone/Bucket Elevator) – Batch type plants use this device to carry the hot aggregate discharged from the drier drum up to the screen deck. Small troughs are continually passing through the flow of aggregate and transport it up to the top of the batch plant tower.

Drum Flights - Depending on the type of asphalt plant, the drier drum may have one or more of the following types of flights. Lifting flights are in all drier drums, they are designed to pass through the aggregate on the bottom of the drum and lift a portion of the aggregate. As the drier drum rotates, gravity takes over and causes the aggregate to fall through the exhausting gases. Farther down the drier drum mixer, mixing flights are installed to do just that, mix aggregate and asphalt binder together. At the rear of the drier drum, discharge flights do just that, discharge the hot aggregate or asphalt concrete mixture into a chute for further processing or storage in a silo.

Screen Deck - At the top of the batch plant tower a set of vibrating screens (screen deck) is used to separate the dried aggregates into different sizes. Typically a four-screen deck is used at most AC batch plant facilities. The top screen is usually the scalping screen, removing oversized materials and sending it to the overflow chute. The remaining screens would separate the aggregate into four different sizes. Screens openings may be slotted, rectangular or square depending on the gradation required.

Overflow Chutes – Each hot bin is equipped with an overflow chute. The chute prevents overflow from one hot bin to another. The plant inspector should be aware of the size of aggregates being discharged from the overflow chute. If an excessive amount of 9.5mm x 12.5mm aggregate is being discharged from the chute, the cold feed bin containing that size of material should be slowed down. This will reduce or eliminate the amount of 9.5mm x 12.5mm aggregate being discharge from the overflow chute.

Asphalt Binder System -- Storage tanks are heated and insulated. Storage tanks are calibrated so the plant inspector can determine the quantity of asphalt binder being stored in each tank. Batch plants utilize a pump and a weigh pot to proportion the asphalt binder, a batch at a time. Continuous mix plants deliver the asphalt binder to the drum through an assortment of pump and meter combinations. The asphalt binder is delivered to the mixing chamber in a constant continuous flow.

Rubberized Asphalt Binder Storage – The components for rubberized asphalt binder, paving asphalt, extender oil, and crumb rubber have different specific gravities. If allowed to set in conventional asphalt storage tanks the ingredients would have a tendency to separate. Caltrans requires that storage tanks for rubberized asphalt binder be equipped with a heating system, temperature indicator, and an internal mixing unit mixers that will keep the binder in a homogeneous condition.

Hot Storage - 19 mm or 12.5 mm maximum sized aggregates that are mixed in batch type plants shall be stored, after being dried; 1) separated into three or more sizes, 2) and each size shall be stored in a separate bin. Storage bins must be equipped with chutes to prevent overflow into adjacent bins.

Proportioning - In simple terms, the amount of each material (aggregates and asphalt binder) that will be combined to produce asphalt concrete. One example might be, 25% of the 12.5 mm x 9.5 mm aggregate, 25% of the 9.5 mm x 4.75 mm aggregate and 50% of the 4.75 mm x 75-µm aggregate. Note the combined aggregate portions total 100 percent. The asphalt binder percent is by dry weight of aggregate and is specified as a percentage. For example, 100 kg of aggregate and 6 kg of asphalt binder indicates an asphalt ratio of 6 percent.

Mass Flow, Coriolis Effect Asphalt Meter and Transmitter - Most continuous mixing AC plants use this type of asphalt meter. A mass flow meter will give the plant inspector a lot of useful information. A few of the features include, asphalt binder production rates (TPH, PPM, GPH, LPM, etc.), total amount of asphalt binder pumped through the meter using the resettable totalizer, specific gravity (pounds per gallon, etc.) of asphalt binder, temperature of the asphalt binder, and span number.

Volumetric Type Asphalt Meter – Some continuous mixing AC plants still use this type of asphalt meter. This meter is only as accurate as the specific gravity input into the controller by the plant operator. The specific gravity is taken from the shipping documents that accompany each load of paving asphalt. Samples of paving asphalt should be taken on a daily basis to verify the specific gravity used by the asphalt meter controller. This type of asphalt meter must be equipped with a functioning temperature compensator. The controller uses the number of pulses per gallon, the temperature correction factor (1.0000 @ 60°F) and the specific gravity to convert volume to mass.

Mixing - Caltrans requires aggregate, supplemental fine aggregate and asphalt binder to be mixed in a batch mixer (pugmill), a continuous mixing pugmill mixer or a continuous mixing drier-drum mixer. In all cases the mixing shall continue until a homogeneous mixture of thoroughly and uniformly coated aggregates of unchanging appearance is produced.

Slat Conveyor – A slat conveyor transports completely mixed AC from ground level to the surge batcher at the top of the mix storage silo. Both batch and continuous mix AC plants can use slat conveyors. Continuous mixing AC plants don't have a choice, all the AC produced from this type of plant must be placed in a silo before being loaded into a truck. A transfer conveyor must be used to transport the completed AC mix from the batch plant pug mill to the slat conveyor.

Reject Chute – All slat conveyors must be equipped with a reject chute. The reject chute is opened whenever the AC mixture is of questionable proportions. This situation may occur at the beginning or end of a plant start-up or shut down. This could also apply to any non-homogenous AC mixture or if the mix temperature is outside of specifications.

Storage - As the completed AC mixture exits the mixing chamber, a drag slat typically transfers the mix to a surge batcher. The surge batcher is mounted on top of the storage silo. Caltrans requires a surge batcher capture at least 1,800 kg of mix before depositing the material into the storage silo. The amount of asphalt concrete or asphalt concrete base in any one silo during mixing shall be a minimum of 18 tonnes, except for the period immediately following a plant shutdown in excess of 2 hours. When asphalt concrete of asphalt concrete base is stored, it shall be stored <u>only</u> in silos. Asphalt concrete or asphalt concrete base shall not be stockpiled. Silos are typically insulated and heated to maintain the mix temperature.

Weights and Measures - Each District employs a Weight's and Measures Coordinator, responsible for calibration and testing all weighing devices and proportioning equipment. All material producing plants used by Caltrans, are required to be tested and approved prior to any use. If the plant passes the California Test 109 and a safety review, the Weights and Measures Coordinator affixes an HC-17 decal indicating the production tolerances and the date of calibration. The California Test 109 is valid for 6 months on continuous mixing type plants, and one year for batch type plants. If repairs are made that affects any proportioning device or plant controls, a new California Test 109 must be performed before the plant produced materials for Caltrans.

Mass Proportioning - Refers to the method used in determining amounts of each ingredient as measured by the plant controller, prior to being combined and mixed. Mass indicates all the ingredients are proportioned by weigh, such as pounds, kilograms or tons.

Volumetric Proportioning - Refers to the way each ingredient is measured by the plant controller before being mixed together. Volumetric indicates all the ingredients are measured in an adjustable calibrated tank, for example, liters, gallons, cubic feet, or cubic meters could be used as the units of measure. This method is not used very much.

Cyclones - Usually the first component of a two-part emission control system. Hot exhaust gases, from the drier drum, containing fine particle of aggregate are carried through the cyclone. The movement of the hot gases and aggregate resembles a cyclone or tornado, hence the name. The larger aggregates fall to the bottom of the cyclone and are returned back to the aggregate steam by an auger or other means.

Wet Scrubber - Typically the second component in a two-part emission control system. After the hot exhaust gases have passed through the cyclone, they are forced through a narrow opening. At that point water is sprayed from multiple nozzles to wet the remaining fine aggregates and dust. The wetted fines and gas are then sent into a circular motion, where the wetted fines fall out of the airflow due to the centrifugal force. The fines then travel out into a settling pond while the exhaust gases exit the stack into the atmosphere.

Knock Out Box - A rectangular shaped collector, used in combination with a baghouse. The system works on a principle of decreasing airflow, allowing coarser dust particles to fall out of the flow. The heaviest fines fall to the bottom of the knockout box where it can be returned to either the batch plant hot elevator or the drier drum mixer. The main purpose of the knock out box is to improve the efficiency of the secondary dust collector by reducing the quantity of fine material being collected in the baghouse.

Baghouse - The second portion of a dust collection system, comprised of a large metal structure containing hundreds of metal cages covered with cloth (Nomex, Kevlar, etc.) bags. At one end of the baghouse, a large exhaust fan pulls dirty air through the metal ducting connecting the baghouse and the drier drum. This process is similar to the way a vacuum cleaner operates, dirty air passing through a filter bag trapping the dirt and expelling clean air. The baghouse is divided into rows or sections, while most of the system is vacuuming a small portion of the baghouse is cleaning the filter bags. This cleaning process may include a system that shakes the bags, reverses the airflow backflushing the filter bags, or a combination of both. The fine particles fall to the bottom of the baghouse where they can be returned to the plant or rejected. Caltrans requires 100 percent returned or 100 percent rejected fines, less than 100 percent must be metered/weighed back into the plant.

Controller - The electronic hardware and circuitry that is adjusted to specific target values by the plant operator, then monitors and adjusts percentages of aggregate, asphalt binder, liquid anti-strip as specified by set tolerances.

Safety Inspection – This safety inspection is performed during the CT 109 and follows the CAL-OSHA regulations, Business and Professions Code, and Caltrans Specifications. If you notice any safety concerns, please contact your District Weights and Measures Coordinator.

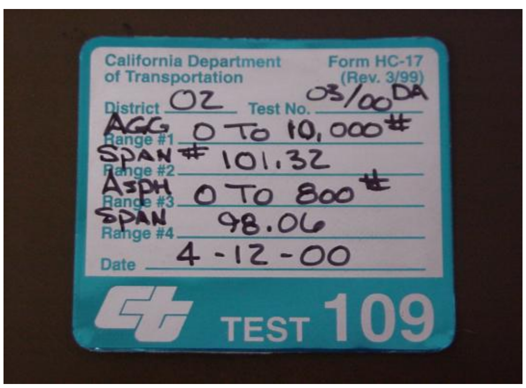
Vehicle Scale – Caltrans requires AC plants to have a vehicle scale located at the plant site. The vehicle scales are checked for accuracy at least once per year. The plant inspector may use a vehicle scale at any time to determine plant production rates or to verify tare and gross weights of trucks hauling AC mix.

Weighmaster – The following is a quote from the Business and Professions Code of California. "A weighmaster is any person who, for hire or otherwise, weighs, measures, or counts any commodity and issues a statement or memorandum of the weight, measure, or count which is used as the basis for either the purchase or sale of that commodity or charge for service."

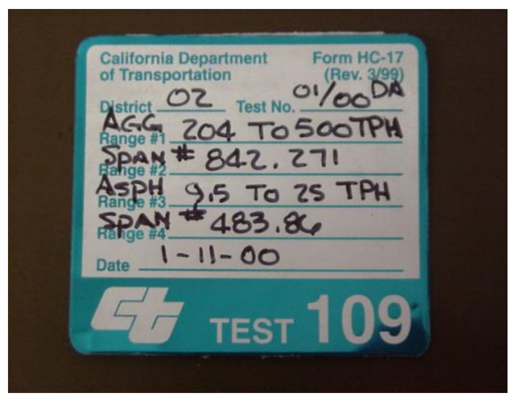
The plant inspector may check weigh any load he suspects to be in error. When weighing any vehicle, the entire vehicle must be on the scale at one time. If the plant inspector is aware of violations by a Weighmaster, the Department of Agriculture, Division of Measurement Standards should be notified at (916) 229-3000.

The 109 Sticker (Form HC-17)

This sticker is affixed to all scale indicators or plant controllers once only after the calibration process, the plant operations and the safety inspection is approved by the District Weight and Measures Coordinator. The 109 sticker will indicate the approved rates the plant is allowed to run between and may include any span numbers used during the calibration process. The following is an example of what the Plant Inspector might see:



Batch Plant



Continuous Mix

Asphalt Concrete Production
Batch and Continuous Mix Plants

Introduction

The purpose of this Plant Inspection Guide is just that "To Guide". It is not meant to be comprehensive, it is simply an outline with general information regarding AC plants and plant inspection. This guide is geared toward an employee who may be new to this type of work or have little experience with asphalt concrete plants. We feel, with the aid of this guide and some on the job training a plant inspector will be able to perform basic AC plant inspections. It will take a considerable amount of time as an AC plant inspector before the employee will gain the experience to understand all aspects of AC plant production. If questions arise about a certain plant or a specific function of the facilities you are inspecting, the Weights and Measures Coordinator in each District Office is always available for consultation.

So you are going to be an AC Plant Inspector? You will be responsible for the acceptance of all the asphalt concrete material on the job, several thousand tons, several million dollars. Many questions come to mind. What will my duties be? What should I be looking for? Are all plants the same? How is the aggregate and asphalt proportioned? How are the aggregate and asphalt mixed? Is the plant calibration current? What do I do if the material does not meet specifications?

Purpose of AC Plant Inspection

To provide inspection of the facility and the materials they produce in conformance with the Caltrans Standard Specifications (Sections 6,9,26,29,39, etc.) and the Contract Special Provisions, also to insure the materials being used in the work conforms to all project requirements. Not enough emphasis can be placed on the documentation of what you observed or didn't observe at the AC plant. You should document all conversations between yourself and the plant operator. A report or diary, stating your observations during the time of inspection, should be written on a daily basis then given to the Resident Engineer and included in the project documents.

Prior to Start of Production

Prior to the start of the project, the Resident Engineer (R.E.) and you should discuss and review all the duties of the Plant Inspector. Chapter 4, Section 39 of the Caltrans Construction Manual may be used as a guide for this dicussion. The R.E. may give you complete jurisdiction, to accept or reject a portion or all of the asphalt concrete mix being made. This responsibility is normally delegated to a Plant Inspector with some prior AC plant inspection experience.

The Plant Inspector should have on hand, enough one quart asphalt sample cans to provide up to two asphalt binder samples per each day of production. A supply of cardboard boxes should be available, in case a sample of the completed AC mixture is required for future testing. A calibrated thermometer or infrared gun for verifying the temperature of the aggregate or the completed mix. When taking aggregate samples, metal pails, sample bags, a sample bag funnel, wire ties, a wire twister, permenant marking pens for labeling sample bags, TL-101 booklets, heavy duty gloves, safety glasses, hard hat and appropiate clothing are required. Be sure to do a few stretching exercises to warm up your muscles and always use the proper lifting procedures. If its to heavy to lift by yourself, get help!

Crushers

This portion of asphalt concrete production is of the utmost importance. If the aggregate is crushed incorrectly, the chance of producing a product that meets specification is almost impossible. It is difficult for an inspector to become familiar with all aspects of a crushing operation in a short period of time, but armed with some basic information, problems with AC aggregates can be corrected before a mountain of material is stockpiled.

Aggregate crushing operations vary in size and type, but the basics are very similar.

This stockpile has problems with segregation, note coarse aggregate at outside bottom edge.

The AC plant inspector should make a habit of visually inspecting the pit or quarry area on a regular basis. Be aware of changes in the material, such as pockets of clayey material, color changes, deleterious rock or excessive vegetation. Document any areas of concern and discuss potential problems with the person in charge of the crushing operation and the Resident Engineer.

Some areas to keep an eye on at the crusher should include the primary and secondary crushers. Are the crushers and screen decks overloaded with material or are they running efficiently? If the crusher (cone or impact) is not being run properly, the particle size percentage will change.

Another area of importance is the screen deck. Are there excessive wear and/or holes allowing oversized rocks to be stockpiled with aggregates? Visual inspection of the stockpiles will indicate if oversized rocks have been passing through the screen deck. Stockpiles should also be examined for areas of aggregate segregation. Pockets of coarse aggregate can develop if the material is dry, or the aggregates fall a great distance from the stacker belt to the ground. For example, if material containing both coarse and fine particles is placed in a stockpile with sloping sides (cone shape), segregation is sure to occur as larger particles roll down the slope. Building a stockpile in layers can minimize this type of segregation.

If the inspector is uncertain of what is causing stockpiles to end up outside the grading specifications, an aggregate sample may be taken from the stacker belt. The grading results of this sample will help to isolate the problem area at the crusher or stockpile area.

Stockpiles

A stockpile is one of the most likely locations to witness segregation of the aggregate fractions. At the crusher, stockpiles of aggregate are typically developed with a stacker belt. If room allows, a loader and/or dump truck are used to haul aggregates from the crusher to a long-term storage area. When a stacker belt is used to stockpile aggregates that are well graded, or contain large and small fractions, segregation of the material is likely to occur. Segregation of a stockpile can be defined as, larger aggregates rolling down the face and accumulating at the bottom of the stockpile.

Numerous preventative measures can be taken to reduce segregation, and contamination of aggregate stockpiles. Place stockpiles on a clean, dry, free draining, stable surface. Asphalt concrete pads may be used to create a solid stable surface. Keep stockpiles of different aggregate sizes separated by space, or if necessary use a barrier to physically keep stockpiles separated. When a staker belt is used to stockpile well graded aggregates, the outside edge will be coarse, and the area below and slightly behind the head pulley will be fine. A rock ladder (photo at left) can be used to minimize stockpile segregation when used in conjunction with a stacker belt.

The loader is NOT removing aggregate from the stockpile in a perpendicular direction.

When a stockpile is created with a dump truck or loader, it should be constructed in a single layer. Additional layers can then be placed on top of the lower layers to create a stockpile with minimal segregation of sizes. Equipment should not be used to push or dump aggregates over the side of a stockpile. Aggregate degradation and stockpile contamination can be reduced if heavy equipment is not allowed on the stockpiles. When a loader is used to move stockpiles created with a stacker belt, removal should occur in a perpendicular direction to the aggregate stream, while working the entire face of the stockpile. The loader operator must make sure to keep the loader bucket from digging into the floor underneath the stockpile, as underlying materials will contaminate the aggregate. When feeding a plant from a stockpile the loader operator should disturb the least amount of aggregate with each bucket of material. The loader bucket should be rolled up through the stockpile to keep from disturbing adjacent material.

If a stockpile does become segregated, the loader operator should re-mix the material before feeding it to the plant. Be careful not to make the segregation worse when re-mixing a stockpile. Discourage a loader operator from feeding one or two bucket of coarse aggregate then one or two buckets of fine aggregate into a cold feed bin in an effort to reblend the material. This practice will cause problems with gradations, moisture content, asphalt content, voids, and stabilities.

Batch Plants

Batch mix plants all work in a similar fashion, starting with a cold feed storage bin feeding continuous flows of aggregates from the coldfeed bins. The virgin aggregates are fed into a drier drum where they are heated and dried. Upon exiting the drier drum, heated aggregates are carried by a hot elevator to the screen deck where they are separated into specific sizes. An example of different aggregate sizes contained in each bin may be, the #1 bin; ¾" x ½", the #2 bin; ½" x ⅜", the #3 bin; ⅜" x No.4, and the #4 bin; No.4 x No.200. The proportions for each batch ingredient are pre-set in the controller. A computer or some other electronic proportioning device automatically controls the weight of individual batch ingredients. The batching system must be fully automatic to the extent that the only manual operation required for proportioning all materials for one batch shall be a single operation of a switch or starter.

An example of a 5-ton asphalt concrete batch with a target of five percent asphalt binder might be:

#1 BIN	**#2 BIN**	**#3 BIN**	**#4 BIN**	**ASPHALT**
1429 lbs.	952 lbs.	3333 lbs.	3810 lbs.	476 lbs.

Storage Bins and Cold Feed Systems

The aggregate storage bins and cold feed system used with a batch type plant, move cold (unheated) aggregate to the plant for processing. A loader is typically used to fill the cold feed storage bins. Extreme care must be taken by the loader operator when scooping up material from the stockpile at ground level. If the loader operator digs too deep, contamination of the aggregates with soil or underlying materials will occur. This type of contamination will affect the gradation, sand equivalent, asphalt content, stability, and other mix qualities. Storage bins must have bulkheads between each bin to prevent intermingling of the different sizes.

Good separation between coldfeed bins is not only good practice, but is required by Caltrans. These large bin dividers will not allow aggregates to over flow into adjacent bins.

Gates located at the bottom of the bins, regulate the amount of aggregate that discharges onto the collection belt. Gate openings can be adjusted to increase or decrease the discharge from each bin. Feeder controls (i.e., variable speed motors) can regulate the amount of material flowing from each bin, too. The system, when functioning properly, provides a continuous and uniform flow of properly graded aggregate to the plant.

An example of poor cold feed adjustment, would be excessive amounts of coarse aggregate (½” x ¾”) appearing at the reject chute and the fine aggregate bin continually running empty. The plant operator can decrease the coarse aggregate feed and increase the fine aggregate feed percentages correcting the problem.

Controlling the cold feed system is the key to all subsequent operations! Problems at the cold feed contribute to a non-uniform mix, which in turn causes problems with the asphalt concrete mixture on the roadway.

Aggregate Drying And Heating

Aggregates are delivered by a series of belts (collection, slinger) to the drum for heating and drying. The batch plant dryer is a revolving cylinder up to 12 feet in diameter and up to 50 feet in length. Fuel used to heat the aggregate may include LPG, propane, natural gas, diesel, heavy fuel oils or reclaimed oil. A blower fan is used to supply air for combustion of the fuel, and an exhaust fan is used to create a draft through the drum. The inside of the drum is equipped with longitudinal troughs or channels, called flights, that lift the aggregate and drop it in veils through the hot gases. The slope of the dryer drum, rotation speed, diameter, length and the flight configuration determine the length of time the aggregate will spend in the dryer.

The inspector must be sure the burner fuel is achieving complete combustion, there should be no signs of black smoke in the air or soot in the settling pond. The exhaust fan creates the draft of air that carries the heat through the dryer drum and removes the moisture. Imbalance between draft air and blower air velocities can cause back pressure inside the drum. This creates a "PUFF-BACK" of exhaust gases at the burner end of the drum. Corrections to the draft air or blower air will correct this problem.

If the aggregate exiting the drier drum exceeds 1% moisture the inspector should look at incomplete fuel combustion, draft air vs. blower air imbalances (puff-back), drier drum slope exceeding ¾” per foot of drum length, worn or missing flights, or aggregate feed rates (TPH) exceeding the capacity of the burner to heat and dry the aggregate. Course aggregates with visible dark spots exiting the drier (use a shovel to sample drier discharge) and steam rising out of hot mix being loaded into trucks are tell tale sign indicating that the aggregate has not been dried enough. If the moisture content of the aggregate exceeds more than 1 %, the Plant Inspector should reject the material at the plant site and have the Contrctor make corrections to the plant processes.

Temperature Control

Proper aggregate/mix temperature is critical. Caltrans specifies that aggregate temperatures shall not exceed 165° C prior to the addition of asphalt. The temperature of the aggregate for Open Graded mixes shall not exceed 135° C. A temperature sensing device placed at the drum discharge along with a temperature indicating device shall be displayed in the control room.

A temperature chart recorder is being used to document the aggregate temperature during all hours of production.

The burner control shown at the right automatically adjusts the damper position to maintain a preset maximum/minimum temperature entered by the plant operator. This system is also a chart recorder, recording the aggregate temperature during all hours of production.

Aggregates that are heated to an excessive temperature can prematurely harden asphalt during mixing. Under heated aggregates are difficult to coat thoroughly with asphalt and cool asphalt mixtures are difficult to place on the roadway. Large fluctuations in temperature could indicate a moisture change within the stockpiles or a cold feed bin that has malfunctioned.

Asphalt mixtures that exceed the maximum allowable temperature, cold asphalt mixtures, asphalt mixtures that contain uncoated aggregates or asphalt mixtures that do no meet the minimum specifications should be rejected at the AC plant by the inspector.

The requirements for all Caltrans QC/QA project specify that an automatic continuous recording device be provided to document aggregate temperatures during all production. Caltrans specs require, when a recording type temperature indicator is used, it shall be maintained in a working condition.

Dust Collection Systems

All continuous mixing plants have a small amount of fine aggregates carried out of the drum. In order to meet Federal, State and Local air quality regulations, dust collection systems must be used to capture dust and exhaust gases that would otherwise be released into the atmosphere. In addition, some dust control systems, (knock-out boxes, cyclones and baghouses) allow the plant operator to control the amount of fine aggregates that are returned to the completed asphalt mix.

Caltrans allows the return of fine aggregates to batch mixing facilities under the following conditions:

1) Fine aggregates collected in “Cyclones” or “Knock-Out Boxes, may be uniformly returned at a point in advance of the aggregate sampling device normally at the hot elevator.
2) Fine aggregates collected in a “Baghouse” shall be stored, kept dry, and proportioned by mass on a separate scale or cumulatively with the aggregate.

Currently, three types of systems are used for dust and emission control. Following are brief descriptions and operating procedures for each type of system.

Dry Collector - Consist of centrifugal collectors, commonly referred to as "cyclone" and expansion chambers, which are typically referred to as "knock-out" or "drop-out boxes". These systems, are usually, the first collectors after the dust leaves the drum. The material collected in these types of systems is much coarser than the fines collected in a baghouse and does not have a profound effect on the asphalt demand when returned to the mix. Fines from these types of collection systems can be returned to the aggregate stream, usually at the bottom of the batch plant hot (stone) elevator.

Types of Deficiencies that May Be Encountered in Producing Asphalt Concrete — PROBLEMS / POSSIBLE CAUSES	Excessive Aggregate Moistures	Inadequate Separation at Bins	Aggregate Feed Gates not Properly Set	Over Rated Dryer Capacity	Dryer Angle to Steep	Improper Dryer Operation	Temperature Indicator Not Adjusted Properly	Aggregate Temperature too High	Screens are Worn Out	Faulty Screen Operation	Bin Overflow not Functioning	Bins Leaking	Segregation of Aggregate in Bins	Carryover in Bins due to Overloaded Screen Deck	Aggregate Scales out of Adjustment	Improper Weighing Procedures	Feed of Mineral Filler not Uniform	Insufficient Aggregate in Hot Bins	Improper Weighing Sequence	Insufficient Asphalt	Too Much Asphalt	Faulty Distribution of Asphalt to Aggregate	Asphalt Scales out of Adjustment	Asphalt Meter out of Adjustment	Undersized or Oversized Batch	Mixing Time Incorrect	Improperly Set or Worn Pugmill Paddles	Faulty Dump Gate	Asphalt & Aggregate Feed not Synchronized	Occasional Dust Shakedown in Bins	Irregular Plant Operation	Faulty Sampling
Asphalt Content does not Match Mix Design			A												A	B				A	A	A	B	C	B	B	A		C			A
Aggregate Gradation does not Match Mix Design		A	A						A	A	B	A	A	B	B	B	A	A							B		A	A	C	A		A
Excessive Fine Aggregate in AC Mixture		A	A						A	A	B	A	A	B	B	B	A	A							B	B			C	A		A
Uniform Mix Temperature Difficult to Maintain	A			A	A	A	A	A																							A	
Truck Weights do not Check with Batch Weights												B			B	B									B							
Excess Asphalt on Mix in Hauling Vehicle															B	B					A	A	B	C	B		A		C			
Excess Dust on Mix in Hauling Vehicle																			B									B				
Large Aggregates are Uncoated	A			A	A	A	A													A		A	B	C	B	B	A		C		A	
Mixture in Truck is not Uniform									A	A	B	A	A	B	B	B	A	A	B			A	B	C		B	A	B	C	A	A	
Mixture in Truck Rich (Too Much Asphalt) on One Side																			B			A			B	B	A				A	
Mixture Flattens in Truck						A															A	A	B	C	B				C		A	
Mixture Burned			A			A	A	A																							A	
Mixture too Brown or Grey (Not Fully Coated)	A			A	A	A	A		A	A	B	A		B	A					A			B	C	B				C		A	
Mixture too Rich (Too Much Asphalt)									A						A	B	A	A			A	A	B	C	B				C		A	
Mixture Smokes in Back of Truck						A	A	A																							A	
Mixture Steams in Back of Truck	A			A	A	A	A																								A	
Mixture Appears Dull in Back of Truck						A	A	A						B	A					A										A	A	

A = Applies to Batch and Continuous Plants B = Applies to Batch Plants C = Applies to Continuous Plants

Wet Collector - Also referred to as a wet scrubber, removes exhaust gases and fines from the drier. The fine particles mixed with exhaust gases are sprayed with water nozzles. The wetted fines, which are relatively heavy, are removed by centrifugal force and fall to the bottom of the collector. The water and fines flow out of the collector and into a settling pond while the hot gases and steam are exhausted into the air through the stack. This system does not return any of the collected fine aggregates back to the plant.

Baghouse – Typically removes dust from the drier that passes the No. 200 sieve, utilizing a principle similar to a giant vacuum cleaner. Exhaust fans pull dust laden air through 100 or more long metal cages, covered with cloth bags to catch the fine dust. Baghouses are typically divided into sections, while some sections are collecting dust; others are using reverse air, a shaker system or a pulse cleaning system to release dust from the outside of the bags. Dust then falls to the floor of the baghouse and travels by auger or conveyor to a central point outside of the system. Caltrans allows two options for the collected dust at this point in the process. The collected dust can either be rejected into a waste pond or returned to the pugmill as described in the following section, "Baghouse Dust Return". If any of the collected fines from the baghouse are to be used in the completed mix, they must be stored in a silo then metered by mass (weight) as a portion of the dry aggregate. The AC plant inspector must be sure that baghouse fines are **not** returned to the hot elevator. If a plant is equipped with an auger or pipe connecting the baghouse to the hot elevator, an inline inspection gate must remain open during all hours of production to insure that baghouse dust is not being returned to the hot elevator.

A few other items the plant inspector should be aware of when a baghouse dust collection system is in use at the AC plant (batch or continuous mix).

1. If the aggregate entering the drier drum has a high moisture content, the fines will have a tendency to cake onto the outside of the bags, reducing the overall efficiency of the dust collection system.

2. If incomplete combustion of the burner fuel is occurring, an oily film will permeate the bags, reducing the overall efficiency of the dust collection system. The oily bags may need to be removed and cleaned by a professional service or replaced.

3. If the aggregate drying temperature is too high, damage to the bags will occur from overheating. The bags may become singed or develop holes, compromising the efficiency of the dust collection system and possibly creating air quality issues. If the bags are damaged in this manner, a light sensitive powder can be introduced into the baghouse air system. Then a monochromatic light (blacklight) is used on each bag to find the ones containing holes.

4. The plant inspector should verify that dust return is at a uniform rate, surges in dust return should be brought to the plant operator's attention and corrected as soon as possible. Caltrans Standard Specifications and contract special provision prohibit surges in the dust return system.

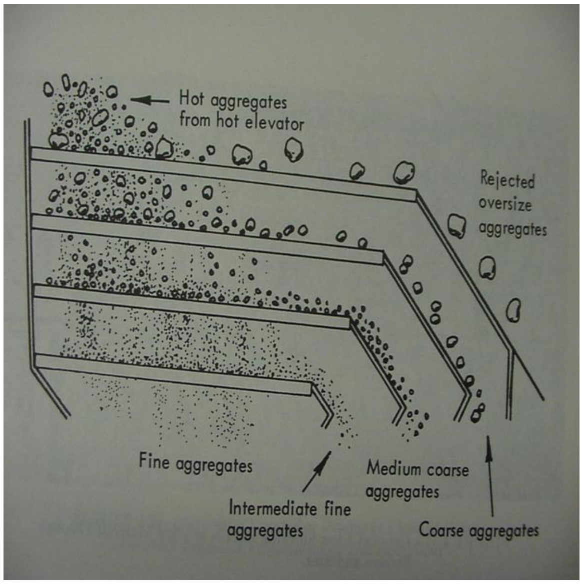
Baghouse Dust Return
When baghouse dust is returned to the mix in a batch plant, it must be proportioned by mass and as required in Section 39-3.03 of the Standard Specifications. The typical system used for returning baghouse dust would include an auger that carries dust from the baghouse to the storage silo, large storage silo, a weigh pot, and a system (high speed) to transport the dust from the weigh pot to the pug mill. The batch controller for this system must be interlocked to the primary batch plant controller. The zero and batching tolerances (interlocks) for this type of dust return system are the same as the tolerances for "supplemental fines", can be found in Section 39-3.03 of the Standard Specifications. The adjacent photograph shows a typical system used for baghouse dust proportioning.

Hot Aggregate Screening And Storage
After the aggregates have been heated and dried, a hot elevator carries them to the screen deck. The screen deck is made up of several different sized vibrating screens. The top screen in the deck is always a scalping screen, which removes oversized rock. Intermediate screens, decreasing in size from top to bottom follow the top screen. At the bottom of the deck is the sand screen. The number of hot bins that will be used to store the different sized aggregates usually determines the number of screens in a deck.

The screen deck separates the aggregates into specific sizes. For this process to work properly, the cold feed rates must be in balance with the screen deck capacity. When excessive amounts of aggregate are fed over the screen deck (blinding the screens), or the screen openings become plugged, smaller sized particles that should have passed through there respective screen opening, ride over the screens and drop into a bin designated for a larger sized aggregates. This is commonly referred to as "carry-over". On the other hand, if screens are worn or torn, oversized material will be deposited into bins intended for smaller sized aggregates.

In any case the screens should be inspected and cleaned regularly by the Contractor.

Excessive carry-over will add to the amount of fine aggregate in the mix. The No. 2 bin is the critical bin for carry-over. This bin will receive the finest aggregate in a carry-over situation and will affect the demand for asphalt the most. Typically, the carry-over into the No. 2 bin should not exceed 10 %. To quickly check the amount of carry-over, run a sample of the No. 2 bin material over a No. 8 sieve to determine the percentage passing.



This is a cross section of a typical batch plant screen deck as it separates the aggregate sizes.

Aggregate hot bins temporarily store the screened aggregates in various sizes required for the type of mix being made. The partitions dividing hot bins must be free of holes and high enough to prevent intermingling of aggregates. Each bin shall be equipped with an overflow pipe to prevent excess aggregates from backing up and overflowing into adjacent bins. When bin overflow does occur, large amounts of aggregate will be discharged from the reject chute. The plant inspector should be able to determine the aggregate size being discharged from the reject chute. This information should be passed on to the plant operator who then can make adjustments to reduce the feed rate of the cold feed bin containing that aggregate fraction. Overflow pipes should be checked frequently for obstructions. Gates at the bottom of hot bins should be checked regularly for proper operation and leaks. Aggregate leaking from a bin will adversely affect gradation of the final mix.

Segregation of coarse and fine aggregate occurs when a bin is allowed to run low, hot bins should never be allowed to run empty. Bin shortages or excesses are corrected by adjusting the cold feed rates. For example, if the fine bin is overflowing and the coarse bin is running empty, the speed of the cold feed supplying the fine aggregate should be reduced while the speed of the cold feed supplying the coarse aggregate should be increased.

AC plant inspectors must know the aggregate gradings for each of the individual hot bins. Then, when a bin percentage change is required because the gradings are out of tolerance, calculations may be made with the proposed bin percentages to determine if the new combined grading is going to bring the grading back into specifications.

Aggregate Sampling At Hot Bins

The asphalt plant inspector is responsible for taking a "***representative aggregate sample***" from each hot bin. From the flow of material over the screen deck, fine aggregates will fall to one side of each bin and coarse aggregates will fall to the other side. This condition is most critical in the fine bin.

The following will help to eliminate improper samples from being taken. The sampling tray must be wider than the flow of aggregate being sampled. The sampling tray must be sized large enough to accommodate a full cross section of the aggregate stream. When pulling the sample trays through the stream of aggregate they should ride smoothly on support rails. Samplers must be pulled through the entire stream of aggregate at a constant speed. The aggregate sample must not overflow the sampling tray during this process.

The sample tray must be pulled through the stream of aggregate at a constant speed to obtain a representative sample. The aggregate sample must not overflow the sampling tray during this process.

If the AC Plant Inspector is not familiar with the plant or the sampling device, always ask the Contractor's plant personnel for assistance.

Batch plant aggregate samples must be lowered from the sampling platform down to the ground level, sometimes twenty to thirty feet below. The contractor is required to provide a means to deliver hot bin samples to ground level. This may include a length of rope with a hook, which can be used to lower the sample container to ground level. Another device for delivering samples to the ground may be a long piece of piping that extends from the sampling area to ground level. This system allows the sample to be poured into a chute at the top of the pipe, the aggregate then falls through the tube to a bucket or sample sack located on the ground.

Aggregate Weigh Hoppers

Aggregates are discharged into the weigh hopper from the hot bins. Normally coarse aggregate is weighed first, succeeded by the next smaller size, and so on. Aggregates weighed in this sequence, prevent fines from leaking out through the gate at the bottom of the weigh hopper. Aggregate discharged from the hot bins should be deposited near the center of the weigh hopper. If aggregates are deposited on one side of the weigh hopper, an imbalance will occur and the scales will not indicate the correct weight.

Caltrans specifications require interlocks be in place, so that "not more than one bin can discharge onto any given scale at one time, and that the weigh box cannot be tripped until the required quantity from each bin has been deposited therein".

Zero tolerance (scales returning to zero after dumping batch) for aggregate scales shall be 0.5 percent (1/2 %) of the total batch weight of the aggregate. Over-under tolerances (amount above or below the pre-selected weight for each bin) for individual weights of each aggregate bin shall not be more than one percent (1 %) of the total batch weight of aggregate.

Asphalt Binder Storage Tanks

Asphalt binder is typically stored in heated and insulated tanks. The tanks are calibrated at 100 gallon intervals (charts for converting inches of asphalt to gallons of asphalt are available from plant operator) and are to be accessible at any time for measuring (stabbing the tanks) the volume of asphalt. Safety is of the utmost importance when sampling asphalt binder or stabbing the asphalt storage tanks. The temperature of conventional liquid asphalt may be as high as 375°F; modified asphalt binders (rubberized) may be heated to temperatures of 400°F. Contact with any material at these elevated temperatures will cause severe burns, always wear long pants, boots, long sleeve shirts, heat resistant gloves, safety glasses and hardhat when working around hot piping and hot asphalt binder. A ½" to ¾" diameter asphalt sampling valve, located in the feed line to the plant, is used by the asphalt plant inspector to obtain a one-quart sample of asphalt binder. The valve opening is to be located 24 to 30 inches above the standing platform used to take the sample. Housekeeping in this area is very important, spilled asphalt should be cleaned up as soon as possible. Drainage receptacles are to be provided for flushing the valve before taking asphalt samples. The minimum amount of liquid asphalt to flush from the valve, prior to sampling, shall be no less than one gallon.

This tank stores the asphalt binder in a horizontal attitude, and at this time is the most widely used for liquid asphalt storage. An insulating layer is located between the heavy metal tank and the thin outside covering.

This tank stores the asphalt binder in a vertical attitude. The vertical tank is better for storing polymer-modified type asphalts, primarily because less air to asphalt contact and an agitation system that keeps the polymers suspended in the asphalt binder.

A temperature-sensing device, accurate to 10° F, must be installed in the asphalt feed line. A temperature-indicating device (LED, LCD, etc.) shall be located in the control room. When supplying asphalt concrete to a Caltrans QC/QA project, an automatic continuous recording device shall be provided to document the asphalt binder temperatures during production. Caltrans a recording type temperature indicator is used, it shall be maintained in a working condition.

Asphalt Binder Weigh Pots

The liquid asphalt is proportioned by weight, as a percent of total dry aggregate. For example, the asphalt content is to be 5 percent, 100 lbs. of dry aggregate would require 5 lbs. of liquid asphalt, and so forth.

The weigh pot is filled with liquid asphalt while the aggregate hot bins are discharging into the weigh bin. The asphalt binder shall be introduced uniformly into the mixer along the center of the mixer parallel to the mixer shafts, or by pressure spraying. The beginning weight of the weigh pot should be checked regularly to verify all the contents are draining completely. Asphalt binder temperature is to be maintained between 250°F and 375°F when added to the aggregate.

Pugmill (Mixing Chamber)

This portion of the plant uses mixing paddles attached to two horizontal shafts that rotate in opposite directions to blend aggregates and asphalt. The Aggregate is first discharged from the weigh hopper into the pugmill and is mixed for about 2 seconds (dry mix time). While the aggregate is still being discharged from the weigh hopper, liquid asphalt is either gravity fed or pumped from the weigh pot to the center of the mixing chamber. After all aggregates and the asphalt binder have been discharged into the pugmill, the controller automatically starts a new weighing cycle with aggregate and asphalt.

At the end of the dry mix time, the aggregate and asphalt are mixed together for a minimum of 30 seconds, to "form a homogeneous mixture of uniformly distributed and properly coated aggregates of unchanging appearance" (wet mix time). Caltrans requires an interval timer for the control of the total mix time. Also, the interval timer must be interlocked so that the mixer can not be discharged until the required mix time has elapsed.

If pug mill paddle tips are worn, wet mix time may need to be increased slightly. Typically, an increase of 3 seconds will produce a well-coated mixture. If more than 3 seconds is required, examine paddle tips for excessive wear or even missing paddles. Clearance between paddle tips and the pugmill liner, exceeding one-half the maximum aggregate size, are considered excessive wear. Non-uniform AC mixtures may also occur when the pugmill is over or under filled. The AC plant inspector should refer to the manufacturers rating for pugmill capacity if this type of mixing problem is suspected. For other causes of non-uniform AC mixtures, refer to Appendix "B", titled ***"Possible Causes of Asphalt Concrete Mix Deficiencies"***.

Note – Appendix "A" depicts the correct and incorrect settings for pugmill paddles.

After mixing is completed, the gates are opened and the batch is dumped into a truck or sent to a storage silo if the plant is so equipped.

Storage Silos

The batch of AC travels from the pugmill to the top of the storage silo by belt conveyor and or a slat conveyor. Caltrans specifies, "Storage silos shall be equipped with a surge-batcher sized to hold a minimum of 4,000 lbs. of material. A surge-batcher consists of equipment placed at the top of the storage silo which catches the continuous delivery of the completed mix and changes it to individual batch delivery and prevents the segregation of product ingredients as the completed mix is placed into storage." The surge-batcher is to be thermally insulated and/or heated. Discharge gates on surge-batchers must be automatic and discharge only after 4,000 lbs. of AC mix has been collected. Discharge gates operated by interval timers are not allowed.

Multiple silos may be used to store different types of asphalt concrete mixtures. The plant inspector must be sure the AC being sent to the project is same as the approved mix design.

AC storage silos are typically insulated and or heated. Caltrans requires a minimum of 20 tons to be retained in the storage silo during AC production. A device (visual or audible) shall be provided at the batching location, indicating the storage level in each silo is maintained above the 20-ton cut off limit.

Automatic Batch Controllers

Batch controllers are a series of electrical circuits or a computer system that automatically controls the entire plant operation. The controllers are checked for accuracy and compliance during the annual California Test 109. Even though they are checked on an annual basis, problems may arise that effect the overall mix proportions. AC plant operators have even been known to turn off a portion of the automatic controls.

The AC plant inspector must understand how the batch plant controller operates. There are many different types of controllers, but the function is basically the same. If the plant inspector is unfamiliar with a specific controller, the District Weights and Measures Coordinator should be able to answer your questions. Manuals for the batch controller are located at the plant site and available to the inspector at all times. The manuals will probably contain the answers to a majority of your questions. Also, the controller manufacturer may be called upon to answer any questions not addressed in their manual. Some other important questions to ask yourself when inspecting an AC batch plant:

Q - Are the batching device interlocks functional?

A - A new batch may not be started until all weigh hoppers are empty, the scales are at zero, and the discharge gates are closed. Caltrans requires all AC batch plants to provide a means to check and verify the over-under tolerances.

Q - Are the aggregate hot bins and the aggregate weigh hopper interlocks functional?

A - No more than one bin may be discharged onto any given scale at one time, and the weigh hopper gates cannot be opened until the required quantity from each bin has been deposited onto the weighing device.

Q - Are the zero tolerance interlocks set correctly and functional?

A - "Zero tolerance" refers to the aggregate and asphalt scales returning to zero before starting a new batch. The "zero tolerance" for aggregate scales is 0.5 percent of the total batch weight of the aggregate, (.005 X AGG). The "zero tolerance" for asphalt scales is 0.05 percent of the total batch weight of the aggregate (.0005 X AGG). The "zero tolerance" can be a plus or minus.

Q - Are the over-under tolerance interlocks set correctly and functional?

A - "Over-under tolerance" refers to the pre-selected weights set on the control panel for each individual aggregate size and the liquid asphalt weigh pot. The "over-under tolerance" for each individual aggregate size deposited in the weigh hopper is 1.0 percent of the total batch weight of the aggregate (.01 X AGG). The "over-under tolerance" for liquid asphalt deposited in the weigh pot is 0.1 percent of the total batch weight of aggregate (.001 X AGG). The "over-under tolerance" can be a plus or minus.

Continuous Mix Plants

Production capacity for continuous mixing AC plants may range from 100 TPH to 700 TPH. A high capacity plant running at 500 TPH can produce 42 tons of completed mix in 5 minutes. The reason for this example, to illustrate the potential for a large quantity of asphalt concrete to be produced in a very short time period.

With this type of plant, a continuous flow of aggregates from the coldfeed bins is heated in a drier drum. The aggregates are delivered in an as-used condition without any subsequent screening, except for the removal of oversized rocks if a scalping screen is in place. After the aggregates have been heated to the desired temperature a continuous flow of asphalt binder is introduced into the drier drum mixer or the pug mill mixer. A computer controls this continuous operation. Caltrans specifications require this operation to be completely automatic.

Continuous Mixing Plant Types:

1) *Continuous drum mixing*
2) *Continuous pugmill mixing*

Storage Bins and Cold Feed Systems

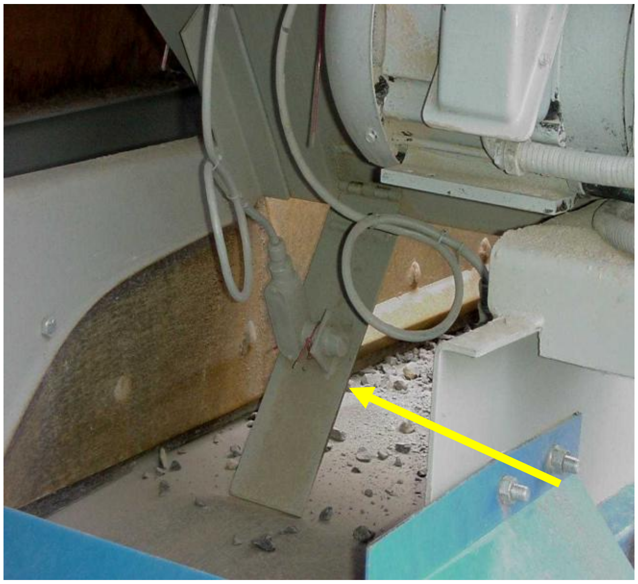
Individual bins are used to store different sized aggregates. Storage bins for continuous mix plants are basically the same as the ones used for batch plants, with a few exceptions. Fine bins (passing the #4 sieve) and supplemental fine aggregate bins must be equipped with a vibrating unit (bin vibrator) to prevent material from hanging up in the bins.

Gates located at the bottom of the bins, feed controlled amounts of different aggregate sizes onto the collection belt. Gate openings can be adjusted to increase or decrease the discharge from each bin.

Anytime a cold feed bin gate opening has been adjusted the bin must be re-calibrated. When a change in material occurs, for example, coarse aggregate replaced with fine aggregate, the bin must be re-calibrated with the new material. Typically, bins are calibrated at 30%, 60% and 100% of the feed capacity. When calibrating bins, individual aggregate sizes are run over a belt scale until the reading appears constant. These points are then plotted along an "X" and "Y" axis in a graph format. Usually, tons per hour and feeder speed percentage are the values used for each leg of the graph. Once the bins have been calibrated, the gate openings should be marked and then checked frequently for movement.

This panel controls the feed rates (TPH) of the cold feed bins manually or automatically.

Cold feed bin gate openings must be calibrated. Bin calibration is the responsibility of the contractor, but the AC plant inspector should be familiar with the calibration charts. Proper calibration will insure correct proportions for the different sized aggregates being delivered to the drier drum.

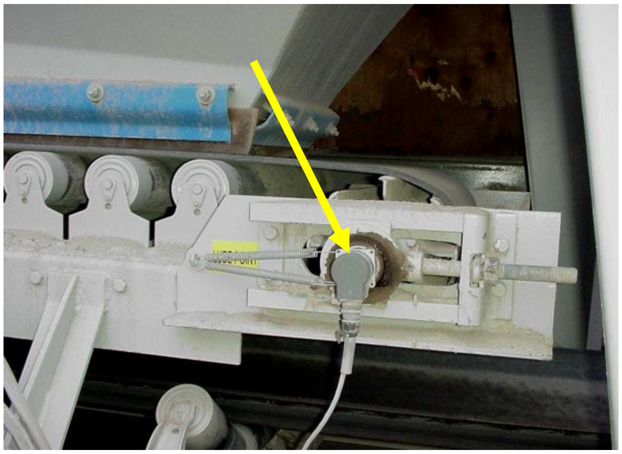


When the aggregate stream is decreased by more than 30 percent, the paddle pictured above will drop down and send a signal to the plant controller.

AC plant inspectors should know the gradings for each individual cold feed bin. Then, if a bin change is required at the cold feed, the Plant Inspector can perform calculations using the proposed bin percentages and determine whether the new combined grading is going to work.

Feeder controls (pictured above) regulate the amount of material flowing from each bin. Each cold feed bin can be controlled by this device as well as the combined aggregate rate for all bins being used to produce any asphalt mixture. Each of the aggregate feeders must be equipped with devices that determine the rate of feed (TPH, RPM, etc.) while the plant is in full production. This system, when functioning properly, provides a continuous and uniform flow of aggregates to the plant.

Caltrans requires a device for each belt feeder, which will monitor the depth of aggregate between the troughing rollers. The Device, commonly referred to as a low-flow interlock, shall automatically shut the plant down when less than 70 percent of the target depth is detected. A time delay of 10 to 15 seconds is allowed between sensing less than 70 percent aggregate flow and plant shutdown. This delay is adjustable and is usually set during the initial California Test 109 and rechecked semi-annually. The time delay interval should be checked regularly by the AC plant inspector. Often during a bin clean out, the device is wired up and out of the way to facilitate the process. If the device stays in the wired-up position, the controller will never detect a low flow condition, even though it may be occurring on a frequent basis.



This "No-Flow" device is attached to the tail pulley and detects movement. No movement, and the plant is automatically shut down.

Caltrans also requires a device, located either in the stream of aggregate beyond the feeder belt or where it will monitor movement of the belt by detecting revolutions of the tail pulley. The device, commonly referred to as a no-flow interlock, must stop the plant automatically and immediately when there is no flow. No time delay is allowed by Caltrans specifications.

From here the collection belt, also referred to as a gathering conveyor, carries combined aggregates away from the cold feeds to the weighbelt.

In most continuous mixing AC plants, a scalping screen is located between the collection belt and weighbelt. This vibrating screen is designed to remove any oversized rock that was inadvertently introduced to the aggregates during processing and stockpiling.

This photo shows the collection belt, then a scalping screen and then the weighbelt. Notice the shielding at the weighbridge (arrow).

Weighbelts

All aggregate weighbelts are required to have concrete footing under-supports for each scale bearing point, per Section 9-1.01, of the Caltrans Standard Specifications. This type of conveyor incorporates a device known as a weighbridge. When the combined aggregates (moisture included) cross the weighbridge, an electronic load cell sends a signal to the weigh belt controller. This electronic signal is meaningless by itself. A second electronic device is also used so that the weigh belt speed can be determined. A belt speed sensor is attached to the tail pulley or the gravity take-up pulley. With the combined signals, the weigh belt controller can calculate the TPH of wet aggregate crossing the weigh bridge.

If aggregates being carried on the belt are relatively dry, all the aggregate that passes over the weighbridge will enter the drum. If the moisture content of the aggregate is high, some of the fine aggregate may stick to the belt. This material will not be fed to the drum, but will remain on the belt. The fine aggregate will accumulate on the belt and be counted by the weighbridge, sending a "false" signal to the computer to increase the asphalt delivery. A properly adjusted belt wiper will prevent material accumulation on the belt.

The AC plant inspector should be aware of the potential problems that may effect this type of continuous weighing system. The following are some examples of things to watch for:

1) Settlement of the concrete footings after the CT 109.
2) Windy conditions without weighbelt shielding.
3) Belt riding to one side of the weighbridge.
4) Aggregate wedged between the weighbridge and the conveyor frame.
5) Weighbelt slipping on tail pulley.
6) Belt zero-check not being performed each morning.
7) Weighbelt not making complete contact with the weighbridge idler.
8) Load cell replaced and not calibrated (CT 109) by Caltrans.
9) Weighbelt repaired, shortened, lengthened, or replaced and not calibrated (CT 109) by Caltrans.

Typically, if any of the above items occur, the amount of aggregate being fed to the plant will be different than that indicated by the weigh belt controller. The completed mix will also have an asphalt content that is different than that specified by the plant controller.

This sampler passes through the entire stream of aggregate at the end of the weighbelt and delivers the sample to ground level.

Aggregate Sampling

The asphalt plant inspector is responsible for taking a "***representative aggregate sample***." Aggregate samplers for continuous mix plants are typically located at the beginning or at the end of the weigh belt conveyor. Samplers come in many different styles, some are automatic and are operated from ground level, while others are manual and must be pushed through the aggregate flow by the plant inspector. During the CT 109, a sample of aggregate taken with the sampler is compared with a sample taken from a belt cross section. The two gradings are compared, if the amount passing each sieve size is within 2 percent when compared directly, the sampler will be approved for use. If an aggregate sampler is modified at a future time, this comparison grading must be done again before it may be used.

The following items will help the plant inspector to obtain representative samples:

1) The sampling device must be wider than the flow of aggregate being sampled.
2) The sampling device must be sized large enough to accommodate a full cross section of the aggregate stream and not over flow.
3) Aggregate samplers must pass through the aggregate stream at a "***constant speed***".
4) If the AC plant inspector is not familiar with a sampling device, the plant operator should be asked for assistance when sampling aggregates.

Aggregate Drying And Heating

Aggregates are delivered by a series of belts (collection, weigh and slinger) to the drum for heating and drying. The continuous mix dryer drum is a revolving cylinder up to 10 feet in diameter and up to 60 feet in length. The following drum configurations are used for a continuous mixing AC plant:

1) **Parallel Flow Drum**: Heated air, aggregate, completed mix and exhaust gases travel in the same direction, all in a downhill direction.
2) **Counter Flow Drum**: Heated air and exhaust gases travel in one direction, while the heated aggregate and completed mix travel in the other direction.
3) **Double Drum**: this design utilizes a drum within a drum, where heated air, aggregate and exhaust gases pass through the inside drum. Heated aggregate passes into the outer drum where liquid asphalt is injected and mixed together in the outside drum.
4) **Parallel/Counter Flow Drum with Coater**: Heated air, aggregate and exhaust gases pass through the drum. The heated aggregate is discharged into a pugmill with the metered asphalt binder and mixed together.

Burner/Blower assembly at discharge end of drum.

Fuel used to heat the aggregate may include LPG, propane, natural gas, diesel, heavy fuel oil or reclaimed oil. A blower fan is used to supply air for combustion of the fuel, and an exhaust fan is used to create a draft through the drum. The inside of the drum is equipped with longitudinal troughs or channels, called flights, that lift the aggregate and drop it in veils through the hot gases. The slope of the dryer drum, rotation speed, diameter, length and the flight configuration determine the length of time the aggregate will spend in the dryer.

The inspector must be sure that the burner fuel is achieving complete combustion, there shouldn't be any signs of black smoke in the air or soot in the settling pond. The exhaust fan creates the draft of air that carries the heat through the dryer drum and removes the moisture. Imbalances between draft air and blower air velocities can cause back pressure inside the drum. This creates a "PUFF-BACK" of exhaust gases at the burner end of the drum. Corrections to the draft air or blower air will correct this problem.

A good rule of thumb for determining the heat transfer between the burner and aggregate is to compare the exhaust gas temperature at the drum exit and the completed AC mix temperature. If both temperatures are within 20°F the drum mixer is operating efficiently and the fuel usage is optimal. If the temperature difference exceeds 20°F the heat transfer is not as efficient, primarily due to the lack of a uniform veil of aggregate falling through the heated air. Regular maintenance of the internal components, such as drying flights, and retainer rings will typically correct the problem as well as reduce emissions.

If the aggregate exiting the dryer drum exceeds 1% moisture, the Plant Inspector should look at incomplete fuel combustion, draft air vs. blower air imbalances (puff-back), drier drum slope exceeding ¾" per foot of drum length, worn or missing flights, or reducing the aggregate feed rates (TPH).

Dust Collection Systems

All continuous mix plants have a small amount of fine aggregates carried out of the drier drum with the exhaust gases. In order to meet Federal, State and Local air quality regulations, dust collection systems must be used to capture dust and exhaust gases that would otherwise be released into the atmosphere. In some areas of California, strict air quality standards have required Contractor's to be pretty innovative. Not only are the dust collection systems in use, but the entire AC plant has been enclosed within a building. These types of systems utilize multiple filtering systems to clean the exhaust gas discharged into the atmosphere. In addition, some dust control systems allow the plant operator to control the amount of fine aggregates returned to the completed asphalt mix.

1) Fine aggregate collected in dust control systems may be returned to the aggregate production stream without any further proportioning if returned at a rate that is commensurate with overall plant production, and if returned at or before the mixer.
2) Fine aggregate returned at a rate less than 100 percent of the collected rate, shall be proportioned by a method that uniformly feeds the material with an accuracy of ± 2 percent. Supplemental fine aggregate shall be discharged directly into the mixer.

Currently, three types of systems are used for dust and emission control.

Dry Collectors – When a baghouse is in use, expansion chambers, usually referred to as "knock-out" or "drop-out" boxes are the first collector after the dust leaves the dryer drum. The material captured in these types of systems is much coarser than the fine dust collected in a baghouse and does not have a profound effect on asphalt demand when returned to the drum. The fine aggregate normally associated with these types of systems must be returned to the plant at a rate of 100 percent or 100 percent rejected. Caltrans specifies if the return of rate is other than 100% of the collection rate it shall be metered.

Wet Collectors - typically referred to as a "wet scrubber", this system removes exhaust gases and very fine dust from the dryer drum. These fine dust particles are mixed with exhaust gases as they exit the drier drum. As the dirty air enters the wet scrubber, nozzles emitting a fine spray saturate the dust laden air. The wetted fines, which are relatively heavy, are removed by centrifugal force and fall to the bottom of the collector. The water and fines flow out of the collector and into a settling pond while the hot gases and steam are exhausted into the air through the stack. This system does not return any of the collected fine aggregates back to the plant. When this type of system is in use, the mix design created for this continuous mixing operation is typically in error. A portion of the fine aggregate used during the mix design is now in the wash pond, decreasing the surface area. With a reduced surface area the asphalt demand should also be less.

Baghouse - removes dust passing the #200 sieve, utilizing a principle similar to a giant vacuum cleaner. Exhaust fans create the suction that pulls the fine dust from the drier drum. After the dust-laden air enters the baghouse, the exhaust fans pull the dirty air through cloth bags to trap the fine dust against the exterior of the bag. A baghouse is typically divided into sections, while some sections are collecting dust, others are using reverse air, a shaker system or a pulse cleaning system to release dust from the outside of the bags. Dust then falls to the floor of the baghouse and travels by auger or conveyor to a central point outside of the system. From this point, all of the collected fines may be rejected or returned at a rate commensurate with the overall plant production. Caltrans specifies if the return rate is other than 100 percent of the collection rate, it shall be metered. Baghouse dust is normally blown or augured back into the mixer, usually at the asphalt add point.

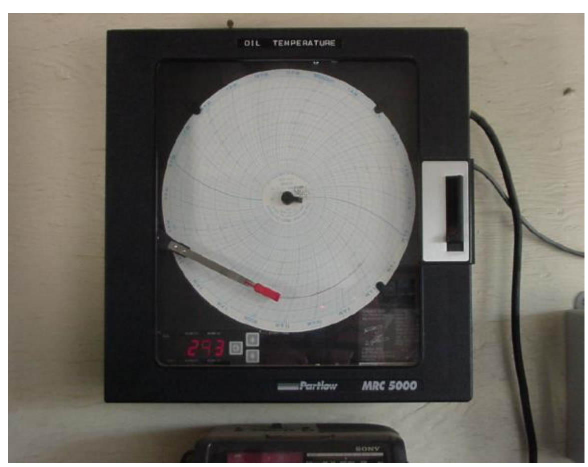
Asphalt Binder Storage Tanks

Asphalt binder is typically stored in heated and insulated tanks. The storage tanks must be calibrated at 100 gallon intervals (charts for converting inches of asphalt to gallons of asphalt are available at the plant), and are to be accessible at any time for measuring (stabbing) the volume of asphalt remaining in the tank.

Caltrans specifications require the discharge end of the asphalt binder circulating pipe be maintained below the surface of the asphalt binder in the storage tank. If hot asphalt binder is discharged into open air, the liquid asphalt will oxidize, thus changing the original composition and viscosity. When hot asphalt binder is discharged into open air, air bubbles are introduced into the liquid asphalt. Asphalt meters other than mass flow coriolis type can not differentiate between liquid asphalt and air bubbles causing the asphalt meter to send a false signal to the controller. One obvious problem that occurs when proportioning liquid asphalt containing air bubbles to aggregates is a dry looking mixture.

A ½" to ¾" diameter asphalt binder sample valve, located in the feed line to the plant, is used to take a one quart sample of asphalt binder. The valve is to be located 24" to 30" above the standing platform and shielded from hot piping. Housekeeping in this area is very important, spilled asphalt should be cleaned up as soon as possible. A Drainage receptacle must be provided for flushing the valve, with a minimum of one gallon of liquid asphalt, before taking the binder samples.

The binder storage tank shall be equipped with a device that will automatically shut down the plant when the level of asphalt binder is lowered to the point that the pump suction line is exposed.



A temperature-sensing device, accurate to 10°F shall be installed in the asphalt feed line. A temperature indicating device (LED, digital readout, etc.) shall be located in the control room.

The requirements for a Caltrans QC/QA project specify that an automatic continuous recording device be provided to document the asphalt temperatures during production. Caltrans also requires, when a recording type temperature indicator is used, it shall be maintained in a working condition. Recorded data shall be retained for the duration of the contract and submitted to the Resident Engineer on request. The Plant Inspector should make it a habit to examine each day's record for excessive temperatures and report any concerns to the Resident Engineer.

Asphalt Metering Systems

The asphalt meter measures the liquid asphalt flow and nothing else. Asphalt pumps move the asphalt through the piping to the mixer. The control valve adjusts the rate of flow after receiving a signal from the controller telling it to do so. The asphalt meter must automatically compensate for changes in asphalt temperature (i.e., temperature corrected to 60°F), unless the meter is of the mass flow, coriolis effect, type. The asphalt meter must be interlocked so that the rates of feed will be adjusted automatically (at all production rates and production changes) to maintain the specified bitumen ration. The asphalt pump, piping and meter must be free of leaks. Most typically, the pump packing will be the first place to look for leaks. If the packing is leaking, the plant operator should tighten the packing flange bolts which should stop the leak. If this doesn't help, the packing may have to be replaced and retightened multiple times until a good seal is created.

During any day's run, the temperature of asphalt binder may not vary more than 50°F. The meter and lines shall be heated and insulated. There are many different types of asphalt meters, but only a few have been type approved for use by the State of California, Department of Agriculture, Division of Measurement Standards.

The following is a list of asphalt meters that are type approved for use in the State of California.

1) **Brooks** (Broodie) - This is an all mechanical meter and includes the automatic temperature compensator (ATC). A temperature corrected signal is sent by the impulse generator to the plant controller and is normally displayed in gallons.

2) **B & S Industries DigiFlow** - This meter uses the same principle as an asphalt pump, but the liquid asphalt is being pushed through it. A gear on top of the unit, drives an impulse generator, which in turn sends a signal to an electronics card. The signal is electronically adjusted and temperature compensated, then displayed at the control panel. The correct specific gravity of the asphalt binder is required for this system to function properly.

3) **Standard Havens DigiFlow** - This meter utilizes the same meter as the Brooks (Brodie) B-43 meter. A gear on top of the unit, drives an impulse generator, which in turn sends a signal to an electronics card. The signal is electronically adjusted and temperature compensated, then displayed at the control panel. The correct specific gravity of the asphalt binder is required for this system to function properly.

4) **Combotronics Total Flow** - This meter is very similar to the B & S Industries DigiFlow meter in appearance and operation. At this time, none of these meters are in use in California.

5) **Mass Flow Meter** (Coriolis Effect) - This meter is very unique, as it has no moving parts. Liquid asphalt is pumped through one or more "U" shaped tubes. The meter determines the liquid flow rate from the action of the "U" shaped tubes when any liquid is pumped through them. Specific gravity and temperature correction is not a factor when this type of meter is used. The meter determines the mass being used, indicates the flow rate and displays the weight in pounds, tons, kilos, etc. Calibration of this type meter is accomplished by changing a "span number". If a remote or hand-held device is needed to view the span number, it must be available at the control room whenever the plant is operating for Caltrans. A large number of asphalt suppliers have converted over to the mass flow, Coriolis effect type meter.

The rectangular object in this photo(indicated by arrow) is the mass flow, Coriolis effect type meter.

If liquid asphalt is proportioned as a percent of total dry aggregate weight ("outside the mix") and the asphalt content is to be 5 percent. 100 tons per hour of dry aggregate would require 5 tons per hour of asphalt binder, and so forth.

For continuous drum mixing plants, liquid asphalt is introduced about 2/3 of the way down the drum and mixed with heated aggregates. If the continuous drum mixing plant is equipped with a double drum, the asphalt is introduced into the outer drum and mixed with heated aggregate. For continuous pugmill mixing plants, liquid asphalt is introduced into the pugmill and mixed with the heated aggregates.

Temperature Control

Asphalt binder shall be at a temperature of not less than 250°F and not more than 375°F when added to the aggregate. Proper asphalt binder/aggregate temperature is critical. Caltrans specifies that aggregate temperatures shall not exceed 325°F prior to the addition of asphalt. A temperature sensing device placed at the drum discharge shall measure the temperature of the AC mixture and shall display the mix temperature on a display located in the control room. Aggregates that are heated to an excessive temperature can prematurely harden asphalt during mixing. Under heated aggregates are difficult to coat thoroughly with asphalt, and cool mix is difficult to place on the roadway. Large fluctuations in temperature could indicate a moisture change within the stockpiles or a bin cold feed that has malfunctioned.

The Contractor shall provide a means of diverting the flow of asphalt concrete away from the silo to prevent incompletely mixed asphalt concrete from entering the silo. The device is also referred to as the reject chute, and is used to divert asphalt mixtures away from the silo that do not meet the minimum and maximum specifications. The Plant Inspector must determine when the completed AC mix is homogeneous and at the proper temperature before allowing the plant operator to close the reject chute. The Plant Inspector must always reject any asphalt concrete that exceeds the temperature requirements specified for the project.

The requirements for a Caltrans QC/QA project specify, an automatic continuous recording device be provided to document the asphalt concrete mix temperature during all hours of production. Caltrans also specifies, when a recording type temperature indicator is used, it shall be maintained in a working condition.

Storage Silos

A surge batcher is located between the top of the slat conveyor and the top of the storage silo.

The completed AC mixture travels from the drum mixer or pugmill mixer to the top of the storage silo by belt conveyor or a slat conveyor. Caltrans specifies, "Storage silos shall be equipped with a surge-batcher sized to hold a minimum of 4000 pounds of material. A surge-batcher consists of equipment placed at the top of the storage silo which catches the continuous delivery of the completed mix, changes it to individual batch delivery, and prevents the segregation of product ingredients as the completed mix is placed into storage. The surge-batcher is to be thermally insulated and/or heated. Discharge gates on surge-batchers must be automatic and discharge only after 4000 pounds of AC mix have been collected. Discharge gates operated by interval timers are not allowed.

Asphalt concrete *__shall not__* be stockpiled. When asphalt is stored, it shall be stored only in silos. AC storage silos typically hold between 75 to 200 tons of mix and are insulated and heated. Caltrans requires a 20 ton minimum be retained in the storage silo during AC production, except for the period immediately following a shutdown of the plant of two hours or more. A device shall be provided at the plant control panel, indicating the storage level in each silo is being maintained above the 20 ton cut-off limit. The storage level indicating device may be either an audible or visual indicator.

Multiple storage silos allows the plant operator a few different options for mix storage. All the silos could be filled with the same kind of asphalt concrete, or they may be used to store different kinds of AC mixes. It is when different mix types are stored at the same time, the wrong type of asphalt mix could be sent to a Caltrans project. An inattentive plant operator could open the gates of the wrong silo, allowing hot AC to drop on the ground, onto a part of the truck that is not designed to haul asphalt, or onto a person in the wrong place at the wrong time.

Multiple silos allow more than one type of asphalt concrete to be stored at the same time.

The Plant Inspector must ensure truck boxes are clean, do not have any material (AC) build up, and are free of any petroleum based release agents. Approved release agents should be used sparingly and visible pooling should be avoided. Visibly inspect AC mixtures being loaded into the trucks, watch for segregation of the mix caused by truck loading to one side, the plant operator opening and closing silo gates numerous times to top off the load, or loading the truck box with only one drop from the silo. Trucks may need to be tarped if the air temperature is cool and some distance is to be traveled from the plant to the paving site. Document all observations in your plant inspection diary.

Continuous Mix Process Controllers

The asphalt plant controller, prior to being used for Caltrans projects, must be approved for use by Headquarters Construction.

Current CT 109 stickers must be affixed to the plant controller or scale indicator. The Plant Inspector must verify the span numbers shown on the CT 109 sticker as well as inspect any physical seals that are in place. If the CT 109 sticker is illegible or missing or if the security seals are broken, the District Weights and Measures Coordinator should be notified and the plant should not be used for asphalt concrete production.

The speed controls for individual aggregate feeders are maintained at the control panel. Once the bin percentages have been established, the aggregate rate (TPH) is increased or decreased using the master control. Controllers receive a wet TPH signal from the aggregate weigh bridge. Dry TPH are then calculated, using the moisture set point in the controller (the moisture set point may be changed at any time). The controller computes the amount of liquid asphalt from the target amount (usually a percentage) entered in the computer. The controller increases or decreases pump speed, to regulate the quantity of liquid asphalt flowing through the meter. Constant minor adjustments of the asphalt pump speed are needed to keep the metered rate consistent with the binder set point vs. aggregate TPH rate.

The controller may change the liquid asphalt count sent from the meter, for example, a gallon count signal is converted by the controller to a TPH count. The calculation is based on the specific gravity or the pounds-per-gallon data keyed into the controller (plants equipped with mass flow meters do not need to do this type of conversion). The plant controller (computer) must be completely automatic in operation.

Liquid Anti-Strip Additive Systems

Caltrans has recently required the addition of liquid anti-strips to asphalt binder on smaller paving projects. Liquid anti-strips act as adhesion promoters between the asphalt and aggregate, improving aggregate to asphalt bonds. At the present time liquid anti-strip is to be proportioned into the asphalt binder at the AC plant. Liquid ant-strip furnished without a "Certificate of Compliance" shall not be used. Only the brand and type of anti-strip used for the AC mix design may be used during production of the asphalt concrete. If the contractor elects to change brands or types of liquid anti-strip a new mix design must be performed. Liquid anti-strip is difficult to move with a conventional pump unless it is heated prior to use. Follow the manufacturer's recommendations for use.

Batch plants use a small vessel to weigh the liquid anti-strip at the rate of 0.5 percent by weight of asphalt binder. For example, if 300 pounds of asphalt binder were used per batch, 1.5 pounds of liquid anti-strip would be needed for each batch. The anti-strip is introduces along with the flow of asphalt binder into the pugmill. This system must operate automatically with the AC batching control equipment.

Continuous mixing AC plants use a mass flow, Coriolis effect meter to proportion liquid anti-strips. For example, while the AC plant is in production 20 TPH of asphalt binder is being used, 200 pounds per hour of the anti-strip would be required to maintain the 0.5 percent by weight of asphalt binder. The system shall be interlocked to the plant controller and adjust delivery rates automatically.

The AC Plant Inspector must take samples of the liquid anti-strip and the asphalt binder prior to the addition of liquid anti-strip.

Vehicle Scales

All asphalt plants are required to have a vehicle scale located at the plant site. The only person allowed to weigh a commodity for sale by mass, is a certified Weighmaster or their assigned deputy. If weighing a combination of vehicles that will not rest on the scale platform at one time, the trailers shall be disconnected and weighed separately. The individual weights may be combined for the purpose of issuing a single certificate. The

AC Plant Inspector may use the scale to verify batch weights or check aggregate and asphalt proportions at continuous mixing plants. The accuracy of the vehicle scale is checked at least once a year. Some scale problems you may run into, could include a bad load cell (display drifting), a bad scale indicator, scale undersupports damaged or out of place, scale pit is full of water, sediment accumulation under any of the scale components, or indicator not zeroed before pulling truck on scale. If the Plant Inspector suspects the vehicle scale is in error contact the District Weights and Measures Coordinator for assistance.

Automated Load-Out Systems

A weighing device that generates load slips based on the weight of material deposited into a haul vehicle. When this type of system is in use, the Weighmaster does not indicate vehicle "gross weights" or "tare weights". Some of the load-out systems the Plant Inspector will see include batch plants with "type approved" software, capturing all batch ingredients and based on the capacity of the haul vehicle, will load the truck with the required number of batches and generate the weigh ticket. Silos that use multiple load cells and a "type approved" computerized software system can generate weight tickets. The system captures the beginning weight of material in the silo, then material is automatically or manually placed in the truck, and the system captures an ending weight of material remaining in the silo. The Plant Inspector may use a vehicle scale to verify weights generated by these types of load-out systems.

Communication

An open line of communication with all the team members is of the utmost importance. The Resident Engineer will want to know if a change in bin percentages is needed, if a change in the asphalt content is being contemplated, if aggregate grading results vary, or any variability with the plant operations is observed. The Materials Laboratory will be able to discuss any changes to test maximum density (TMD), stabilities, or voids, which would indicate changes to the AC mixture. The Street Inspector is a good resource for windrow and mat temperatures, mix segregation and where it is occurring (i.e., truck, windrow or mat) as well as any issues with trucking. The Street Sampler/tester will have information about the relative compaction. Problems with relative compaction could indicate changes to aggregate proportions or asphalt content. The Plant Operator is a wealth of knowledge for the Plant Inspector, and vice-a-versa. Keeping an open line of communication at this level is invaluable.

The 109 Test

Every AC plant, whether batch or continuous mix must have a current CT 109 certification as well as a safety inspection. Batch Plants must have the CT 109 performed one per year while continuous mix plants must have a CT 109 performed one every six month. A new CT 109 must be performed again if either type of plant has been moved or if repairs have affected any proportioning device or scale.

The Plant Inspector should request a current copy of the "CT 109" and the "Safety Inspection" for each facility from the District Weights and Measures Coordinator. The CT 109 will indicate the maximum and minimum parameters for AC production, span numbers, safety concerns or other issues. If the Plant Inspector has questions about any area of the AC plant the District Weight and Measures Coordinator should be contacted.

Safety

The Plant Inspector is exposed to a variety of potential hazards. Around any kind of a plant or crushing operation, dust is generated and dispersed into the air. Dust can contain silica, which may be hazardous to your health. As you breathe the air, fine particles of dust may also enter your lungs. When worn properly, dust masks can reduce or eliminate dust in the air you breathe.

The Plant Inspector must be on the alert for haul vehicles and heavy equipment moving around the plant. Loaders are moving quickly, backing and turning trying to keep up with plant production or stockpile operations. Limited visibility around the plant site as well as blind areas on all sides of the equipment make it difficult for the operator to see. Always make positive eye contact with the truck driver or operator before crossing in front of or behind any equipment.

Most of the surfaces at asphalt plants are very hot. If the Plant Inspector does not have the proper protective clothing, such as long sleeve shirts and gloves, the potential to receive a nasty burn is quite high. When sampling asphalt binder, protective clothing and gloves are essential. Safety glasses are a must when the Plant Inspector is around the production facility or is sampling hot asphalt. Your hard hat will protect your head from these hot surfaces, too.

The Plant Inspector must also be aware of moving belts, revolving drums, low overhead clearance, pinch points, lifting hazards, and tripping hazards. Never stop thinking about safety. The Caltrans Safety Motto "Safety is no Accident".

AC Mix Designs

A copy of the approved mix design, indicating the aggregate source, manufacturer and grade of asphalt binder, and plant proposed to mix the AC, must be in the possession of the Plant Inspector. A mix design will typically show the aggregate bin percentages, gradings, LA rattler, Durability (course and fine), sand equivalent, cleanness value, aggregate specific gravity, recommended OBC, stabilities, abrasion, swell, voids, and test maximum density. The mix design is intended to be a starting place for mix production and may need to be tweeked slightly to meet the desired requirements.

Aggregate Testing

Aggregate samples are taken at various intervals, depending on the type of project. For non-QC/QA projects, Section 6 of the Construction Manual, requires Caltrans to perform a sieve analysis once for every 500 tons of mix production, 2 per day maximum. For QC/QA projects, the special provisions require the QC laboratory to perform a sieve analysis for every 500 tons of mix production and Caltrans to verify the sieve analysis at least once for every ten tests (sieve analysis) performed by the QC laboratory.

If lime slurry marination is required by the contract some test results may be in error. Production tests for cleanliness and sand equivalent will be in error if the testing occurs after lime treatment. Therefore, samples for cleanliness and sand equivalent must be taken from stockpiles prior to lime slurry treatment. Exercise care in obtaining representative samples when sampling in this manner. Sieve analysis may be performed on aggregates after lime slurry marination without a significant affect on the grading results.

Completed Mix Sampling and Testing

All testing on the AC mixture is performed on samples obtained from the street following the instructions in CT 125. Always take enough of sample to perform all the desired tests. It is always better to have too much material than to not have enough.

Failing Test Results

It is the Plant Inspectors responsibility to inform the Resident Engineer of any failing test results as soon as possible. Retain any split portions for all samples taken, until the Resident Engineer instructs you to discard it.

Tricks of the Trade

If the aggregate samples are very wet, spread them out on a sheet of metal placed in the direct sunlight. This method along with a little stirring will dry out the sample very quickly. The sample only has to be dry enough so that the fines won’t stick to larger aggregates or the screens used for sieving. This will greatly reduce the overall time required to perform a sieve analysis.

You are inspecting at a continuous mixing AC plant, and the aggregates have been treated with lime slurry. Looking at the mixture being discharged from the drum mixer, you notice some uncoated coarse aggregate. The lime residue when mixed with the liquid asphalt has a tendency to increase the viscosity of the asphalt binder. A couple of changes can be made to correct this situation. Increasing the temperature of the asphalt binder or increasing the temperature of the completed mix will help coat all the aggregate. The asphalt binder’s viscosity is reduced if the temperature is increased allowing for a better distribution of the asphalt cement. Be sure to keep an eye on the maximum allowable temperatures for the asphalt binder and the completed mix.

Hot Stops and Hot Starts

As a Plant Inspector it is your responsibility to insure all AC mixtures purchased by Caltrans meet the minimum specification. When a plant operator performs a hot stop, the proportioning of the aggregate, dust and asphalt binder no longer meet our tolerances. If the aggregate and asphalt binder drop above or below the approved production rates established during the CT 109, proportioning error is know unknown. If the drum is left full of aggregate, the hot asphalt binder can drain out of the spray bar and over asphalt the aggregate still in the drum. All AC mixtures with unknown proportions or adequate temperatures should be rejected and not sent to the silo.

APPENDIX

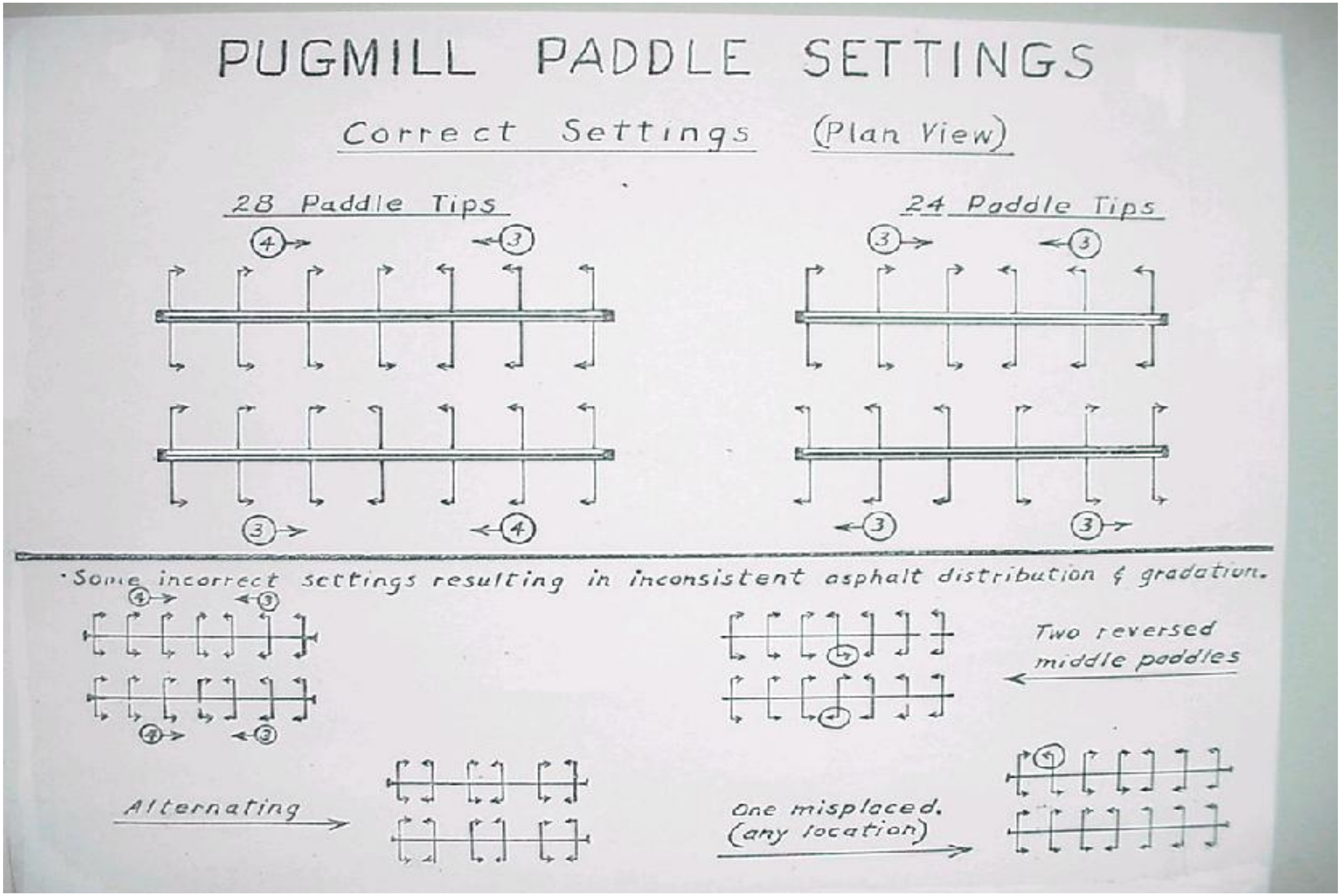
Pugmill Paddle Settings - Appendix “A”

Mix Deficiencies Encountered During Production - Appendix “B”

Inside-Outside Asphalt Content Chart – Appendix “C”

Plant Inspection Checklist (being developed) - Appendix “D”

Appendix No. "A"



Appendix No. "B"

Types of Deficiencies that May Be Encountered in Producing Asphalt Concrete — POSSIBLE CAUSES / PROBLEMS	Excessive Aggregate Moistures	Inadequate Separation at Bins	Aggregate Feed Gates not Properly Set	Over Rated Dryer Capacity	Dryer Angle to Steep	Improper Dryer Operation	Temperature Indicator Not Adjusted Properly	Aggregate Temperature too High	Screens are Worn Out	Faulty Screen Operation	Bin Overflow not Functioning	Bins Leaking	Segregation of Aggregate in Bins	Carryover in Bins due to Overloaded Screen Deck	Aggregate Scales out of Adjustment	Improper Weighing Procedures	Feed of Mineral Filler not Uniform	Insufficient Aggregate in Hot Bins	Improper Weighing Sequence	Insufficient Asphalt	Too Much Asphalt	Faulty Distribution of Asphalt to Aggregate	Asphalt Scales out of Adjustment	Asphalt Meter out of Adjustment	Undersized or Oversized Batch	Mixing Time Incorrect	Improperly Set or Worn Pugmill Paddles	Faulty Dump Gate	Asphalt & Aggregate Feed not Synchronized	Occasional Dust Shakedown in Bins	Irregular Plant Operation	Faulty Sampling
Asphalt Content does not Match Mix Design			A												A	B				A	A	A	B	C	B	B	A		C			A
Aggregate Gradation does not Match Mix Design		A	A						A	A	B	A	A	B	B	B	A	A							B		A	A	C	A		A
Excessive Fine Aggregate in AC Mixture		A	A						A	A	B	A	A	B	B	B	A	A							B	B			C	A		A
Uniform Mix Temperature Difficult to Maintain	A			A	A	A	A	A																							A	
Truck Weights do not Check with Batch Weights												B			B	B									B							
Excess Asphalt on Mix in Hauling Vehicle															B	B					A	A	B	C	B		A		C			
Excess Dust on Mix in Hauling Vehicle																			B									B				
Large Aggregates are Uncoated	A			A	A	A	A													A		A	B	C	B	B	A		C		A	
Mixture in Truck is not Uniform									A	A	B	A	A	B	B	B	A	A	B			A	B	C		B	A	B	C	A	A	
Mixture in Truck Rich (Too Much Asphalt) on One Side																			B			A			B	B	A				A	
Mixture Flattens in Truck						A															A	A	B	C	B				C		A	
Mixture Burned			A			A	A	A																							A	
Mixture too Brown or Grey (Not Fully Coated)	A			A	A	A	A		A	A	B	A		B	A					A			B	C	B				C		A	
Mixture too Rich (Too Much Asphalt)									A						A	B	A	A			A	A	B	C	B				C		A	
Mixture Smokes in Back of Truck						A	A	A																							A	
Mixture Steams in Back of Truck	A			A	A	A	A																								A	
Mixture Appears Dull in Back of Truck						A	A	A						B	A					A										A	A	

A = Applies to Batch and Continuous Plants B = Applies to Batch Plants C = Applies to Continuous Plants

Appendix No. "C"

INSIDE - OUTSIDE ASPHALT CONTENT

Caltrans - asphalt content is specified as a percentage of the dry aggregate weight = "Ouside the Mix"
Others - Some agencies specify the asphalt content as part of the total mix = "Inside the Mix"
*****Note -*** Varations in the production rate will not alter these results if the "target" (ordered asphalt content) remains constant

CALTRANS *Outside* "TARGET" % Asphalt	***OTHERS*** *Inside* *"FALSE"* % Asphalt	Multiplier % Change	Difference US - OTHERS
1.5	1.478	0.9853	0.0220
1.6	1.575	0.9844	0.0250
1.7	1.672	0.9835	0.0280
1.8	1.768	0.9822	0.0320
1.9	1.865	0.9816	0.0350
2.0	1.961	0.9805	0.0390
2.1	2.057	0.9795	0.0430
2.2	2.153	0.9786	0.0470
2.3	2.248	0.9774	0.0520
2.4	2.344	0.9767	0.0560
2.5	2.439	0.9756	0.0610
2.6	2.534	0.9746	0.0660
2.7	2.629	0.9737	0.0710
2.8	2.724	0.9729	0.0760
2.9	2.818	0.9717	0.0820
3.0	2.913	0.9710	0.0870
3.1	3.007	0.9700	0.0930
3.2	3.101	0.9691	0.0990
3.3	3.195	0.9682	0.1050
3.4	3.288	0.9671	0.1120
3.5	3.382	0.9663	0.1180
3.6	3.475	0.9653	0.1250
3.7	3.568	0.9643	0.1320
3.8	3.661	0.9634	0.1390
3.9	3.754	0.9626	0.1460
4.0	3.846	0.9615	0.1540
4.1	3.939	0.9607	0.1610
4.2	4.031	0.9598	0.1690
4.3	4.123	0.9588	0.1770
4.4	4.215	0.9580	0.1850
4.5	4.306	0.9569	0.1940
4.6	4.398	0.9561	0.2020
4.7	4.489	0.9551	0.2110
4.8	4.580	0.9542	0.2200
4.9	4.671	0.9533	0.2290
5.0	4.762	0.9524	0.2380
5.1	4.853	0.9516	0.2470
5.2	4.943	0.9506	0.2570
5.3	5.033	0.9496	0.2670
5.4	5.123	0.9487	0.2770
5.5	5.213	0.9478	0.2870
5.6	5.303	0.9470	0.2970
5.7	5.393	0.9461	0.3070
5.8	5.482	0.9452	0.3180
5.9	5.571	0.9442	0.3290
6.0	5.660	0.9433	0.3400

CALTRANS *Outside* "TARGET" % Asphalt	***OTHERS*** *Inside* *"FALSE"* % Asphalt	Multiplier % Change	Difference US - OTHERS
6.1	5.749	0.9425	0.3510
6.2	5.838	0.9416	0.3620
6.3	5.927	0.9408	0.3730
6.4	6.015	0.9398	0.3850
6.5	6.103	0.9389	0.3970
6.6	6.191	0.9380	0.4090
6.7	6.279	0.9372	0.4210
6.8	6.367	0.9363	0.4330
6.9	6.455	0.9355	0.4450
7.0	6.542	0.9346	0.4580
7.1	6.629	0.9337	0.4710
7.2	6.716	0.9328	0.4840
7.3	6.803	0.9319	0.4970
7.4	6.890	0.9311	0.5100
7.5	6.977	0.9303	0.5230
7.6	7.063	0.9293	0.5370
7.7	7.149	0.9284	0.5510
7.8	7.236	0.9277	0.5640
7.9	7.322	0.9268	0.5780
8.0	7.407	0.9259	0.5930
8.1	7.493	0.9251	0.6070
8.2	7.579	0.9243	0.6210
8.3	7.664	0.9234	0.6360
8.4	7.749	0.9225	0.6510
8.5	7.834	0.9216	0.6660
8.6	7.919	0.9208	0.6810
8.7	8.004	0.9200	0.6960
8.8	8.088	0.9191	0.7120
8.9	8.173	0.9183	0.7270
9.0	8.257	0.9174	0.7430
9.1	8.341	0.9166	0.7590
9.2	8.425	0.9158	0.7750
9.3	8.509	0.9149	0.7910
9.4	8.592	0.9140	0.8080
9.5	8.676	0.9133	0.8240
9.6	8.759	0.9124	0.8410
9.7	8.842	0.9115	0.8580
9.8	8.925	0.9107	0.8750
9.9	9.008	0.9099	0.8920
10.0	9.091	0.9091	0.9090
10.1	9.173	0.9082	0.9270
10.2	9.256	0.9075	0.9440
10.3	9.338	0.9066	0.9620
10.4	9.420	0.9058	0.9800
10.5	9.500	0.9048	1.0000
10.6	9.579	0.9037	1.0210

Appendix No. “D”